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COMPLETE SPECIFICATION.

" Improvement in Apparatus for Rendering Possible Breathing in Atmosphere Containing Smoke or Injurious Gases "

I, Bernhard Loeb, of Wormserplatz 23, Cologne, in the Empire of Germany, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement:

This invention relates to improvements in apparatus for rendering possible breathing in chambers or places containing injurious gases and adapted to render the gas inhaled from such chambers suitable for breathing purposes with the aid of dry filters and liquids and in some cases to render the exhaled gases suitable for re-inhaling and for supplying artificial oxygen and fresh air obtained from the atmosphere.

In the annexed drawings, Fig. 1 is a front view of the improved apparatus with two dry filters and one liquid filter for purifying the air. Fig. 2 is a vertical section of the apparatus, Fig. 3 a horizontal section on the line A—B of Fig. 2, Fig. 4 a longitudinal section of a double bottomed tube for shutting off the liquid in the liquid reservoir, Fig. 5 a longitudinal section of another form of this tube. Fig. 6 an elevation of a cartridge for containing the dry filtering material, Fig. 7 a front view of a detail of the apparatus shown in Figs. 1 to 3, for the preliminary purifying of the air, Fig. 8 a front view of the same detail with the cover removed, Fig. 9 a side view thereof and Fig. 10 a vertical section. Fig. 11 is a front view of an apparatus with four dry filters and one liquid receptacle. Fig. 12 is a vertical section on the like C—D of Fig. 13, Fig. 13 a horizontal section on the line E—F of Fig. 11, Fig. 14 a plan view of an apparatus with three dry filters and four liquid receptacles and means for rendering breathable exhaled air. Fig. 15 is a vertical section on the line G H of Fig. 14, Fig. 16 a vertical section on the line J K of Fig. 14, Fig. 17 a vertical section on the line L—M of Fig. 14, and Fig. 18 a plan view of an apparatus with three drying filters, two liquid receptacles and means for rendering breathable exhaled air and for the supply of artificial oxygen and fresh air from the atmosphere. Fig. 19 is a vertical section on the line N O of Fig. 18, Fig. 20 a front view of the apparatus, Fig. 21 a section on the line P Q of Fig. 18, Fig. 22 a section on the line R—S of Fig. 18, Fig. 23 a section on the line T—U of Fig. 18, Fig. 24 a side view of a modification of the apparatus shown in Fig. 18 to 23 and Fig. 25 a plan view of this modified apparatus. Fig. 26 is a diagram illustrating the action of the apparatus shown in Figs. 18 to 25 and Fig. 27 shows a modification in the apparatus shown in Fig. 18.

Referring to Figs. 6 to 8. In apparatus for rendering possible breathing in atmosphere containing smoke or injurious gases, with the aid of certain liquids in combination with dry filters for purifying or cooling the air inhaled, arrangements must be made to prevent the entrance of the liquid to the mouth-tube or the like or to other parts of the apparatus when the latter is moved, without of course interfering with the free passage of the air purified or to be purified. For this purpose use is made of the fact that liquid in motion, more particularly

[*Price 8d.*]

if somewhat viscous, or thick flows past narrow apertures without entering them if the said apertures are more or less parallel to the direction of flow, whereas air passes freely through the said apertures.

The tube *a* in Fig. 4 is assumed to be the one through which air is to be sucked towards the mouth in the direction of the arrow 1. At the lower end of the tube *a* a flange *b* is provided and at a short distance below the latter a plate *c* connected to the said flange by brackets *z z*, so that, as it were, a tube is formed with a double bottom *b c* open at the sides. Air can enter the annular slot in the direction of the arrows 2 and pass to the tube *a*. If however, any of the liquid should flow to this part of the apparatus, as for instance through excessive tilting, it will flow more or less in the direction of the arrow 3 and will therefore not enter the said annular slot but will be caused by the co-hesion of its particles to flow past the slot as indicated by the arrows 4. The purifying liquid generally used is glycerine, which has the property in question to a particular degree, owing to its viscosity. Stopping devices of this kind are not only provided for the tubes leading to the mouth but at all parts of the apparatus where there is danger of liquid getting access to places where it would be injurious and from which it would be difficult to remove it as a result of shaking or movement of the apparatus.

This is shown in Figs. 1 to 3 in connection with an apparatus with two dry filters and one liquid receptacle. In this apparatus the unpurified air enters the chamber *f* through the tube *d* and then passes through the tubes *g g* and *i* to the tube *k* at the foot of which is the first stopping device *m* of the kind described. Air then passes through the bell *n* to the pipe *o* at the foot of which is the second stopping device *p* which extends into the purifying liquid *q* in the resting position. The air passes through this liquid and ascends past the screen *r* between the conical insertion *s* and the bell *n* to the breathing tube *a* (also Fig. 4) at the foot of which is the fluid stopping device *b c*. This apparatus, like those hereinafter described, is adapted to be carried on the back and is therefore not only liable to be shaken but also to be more or less tilted. Without the stopping devices the liquid *q* would then enter the pipe *o* and pass through the tubes *k* and *i* to the filter chambers *h h* and would also flow into the breathing tube *a*. The passage of liquid to the latter is for the most part prevented by the stopping device *p* The latter admits the liquid at rest to the height of the latter's normal level: this is of no disadvantage and even desirable for the passage of air through the liquid. As soon, however, as the liquid begins to flow the action above described occurs, by which the liquid flows past the narrow annular slot of the device *p* without passing therethrough. If a portion of the liquid should enter the tube *o* it will be stopped, together with the liquid that was already in the latter, by the device *m* so that the liquid at all will pass to the filter chambers *h h*. Liquid tending to flow to the breathing tube will be stopped or choked back first by the screen *r* and the funnel *s* and then by the device *b c* if any should reach the latter. Instead of the screen *r* another stopping device can be placed at the foot of the funnel *d* as indicated by dotted lines or where the screen is.

Fig. 5 represents a modification of the double bottomed tube in which a wall *v* with narrow apertures *x* closes the annular slot between the bottoms *t* and *u*. It is obvious that with this construction the distance between said bottoms can be increased, since the stopping of the liquid now depends on the area of the apertures.

The above described improvement relates to the liquid receptacle. Another improvement relates to the dry filter. The filtering substances must be renewed from time to time and with large apparatus, this is not effected without considerable difficulty and it has been found more particularly that the filling has been insufficient if performed by inexperienced persons. I therefore enclose the proper charges in cartridges completely closed and fastened by screws or other means to the respective chambers of the apparatus. To avoid the necessity of very frequently exchanging these cartridges an exchangeable device is provided for cleansing smoke filled air by holding back the so-called "flakes" of smoke.

Fig. 6 represents a filter cartridge, Figs. 7 to 10 the preliminary cleanser, and Figs. 1 to 3 illustrate the attachment of the cartridges and cleanser.

The impure air and smoke entering the tube *d* (Fig. 1) passes to the chamber *f* containing the wool 5.

The latter is placed between the sieve 6 and the screw cover 7 which carries the boss 8 for the tube *d*. From the wool, the air, already freed from smoke flakes, passes in the manner already described through tubes *g g* to the cylinders *h h* containing filter cartridges 10 10. Each of the latter consists of a metal cylinder with sieves 11 and 12 soldered to its ends and provided with a screw thread 13 (Fig 6) for screwing it into the cylinders *h h*, the latter being threaded at 14 for that purpose.

The air is so conducted as to pass through the cartridges axially from below to the top, but can also be so conducted as to pass downwards through the cartridges.

The cartridges 10 10 are considerably protected by the wool 5 and therefore require to be exchanged less frequently. To renew the preliminary cleanser it is only necessary to remove the wool 5 and insert fresh and to replace the filtering cartridges those in the apparatus are withdrawn and replaced by fresh ones containing filtering material. The filtering material in the cartridges is inaccessible to the user of the apparatus, since the cartridges are completely enclosed and have to be used as supplied by the maker with the proper charges.

In large apparatus care must be taken that the user can conveniently inhale air through the whole layer formed by the material in the dry filter and the liquid receptacle. It is therefore advisable to divide the filtering and liquid layers several times, and to provide comparatively large air-spaces, more particularly above and below the dry filters. Experiments have shown this to considerably facilitate breathing.

In the apparatus shown in Figs 1 to 3 air spaces of this kind are provided, formed more particularly by arranging the cartridges 10 in the cylinder *h* with comparatively large air spaces at top and bottom.

In the large apparatus shown in Figs. 11 to 13 the entire dry filter layer is divided four times, four dry filter cartridges being used. It may be mentioned that in this case only one liquid receptacle is used.

The impure air enters in the known manner through the tube 15, passes to the chamber 16 for preliminary cleansing, and then divides into two currents which flow through the tubes 17 and 18 respectively to the cylinders 19 and 20.

As already stated, the cartridges 10 are so arranged in the latter that considerable air spaces remain above and below. When the air has passed through the cartridges 10 it flows through the pipes 21 and 22 to the bases of the cylinders 23 and 24 in which further cartridges 10 are provided with air spaces above and below them. After passing upwards through these cartridges the air currents unite in the pipe 25 and pass through 26 to the hollow cone 27. The latter is within a cylindrical chamber 28, through which the above mentioned connecting pipe 25 partly passes. The cylindrical chamber 28 and the hollow cone 27 also form air spaces which facilitate the suction of air. The air is sucked through the purifying and cooling liquid 29 at the bottom of the receptacle 28 and then ascends and passes through 30 to the breathing pipe. As shown in the drawing, the liquid stopping devices 26 and 29 are used in this apparatus also.

In the apparatus shown in Fig. 14 to 17 more receptacles for filtering material and liquid are provided and there is also provided an arrangement for rendering breathable the exhaled air.

The air enters through the tube 31 and passes through the preliminary cleaning chamber 32, whereupon it divides into two currents which flow through the pipes 32 and 34 to the receptacles 35 and 36. The arrangement of the latter is similar to that of the receptacle 28 in Fig. 11 to 13, and this is also the case with the third vessel 37. The air passes through the liquid at the bottom of the receptacles 35 and 36, passing downwards between the hollow cones 38 and 39 and upwards inside the latter, whereupon the air currents unite in the connecting tube 40 and then pass through the liquid in the third vessel 37. In doing so its direction is reversed, that is to say it descends inside the cone 41 and ascends outside the latter. The air then passes through the pipe 42 to the space 43 in the large chamber 44 before entering the filter 45.

The chamber 43 must also be regarded as a large air space. The cylindrical filter 45 is so arranged as to be surrounded by an air space limited by a rubber bag 46 from which the air passes to another air space 47 and then through pipes 48 and 49 to the cylinders 50 and 51. The arrangement of the latter is similar to that of the cylinders 19, 20 23, 24 of Fig. 13. That is to say, they are provided with filters 10 above and below which considerable air space is provided. The air ascends in these filters and passes in the manner described through a vessel 52 with liquid at its bottom and then through 53 to the breathing tube.

The following remarks must be added to render the apparatus understood.

The filters 10 (Fig. 15) contain some substance adapted to absorb carbon dioxide, as for instance hydrate of soda or the like, since their main purpose is to render breathable the exhaled air. The latter is not exhausted into the open with this apparatus but re-inhaled after the carbon dioxide has been absorbed. For this purpose anti-return valves 55 are provided above the tube 53 from which the air passes to the breathing tube 54. The valves open during inhalation and close during exhalation. In the pipe 56 connected to the breathing tube a valve box 57 of the opposite arrangement is provided, that is to say, the valve closes during inhalation and opens during exhalation. The exhaled air is thus forced through the pipe 58 to the large chamber 44 and to the rubber sack 46, which expands correspondingly. The said rubber bag thus receives both the air inhaled from outside and the exhaled air. During the next inhalation, therefore, the previously exhaled air is forced through the vessels 50 51 52 together with the freshly inhaled air which has already passed through the liquid receptacles 35 36 37. The charge of the filters 10 herein absorbs the carbon dioxide, more particularly from the exhaled air, and the latter is thus rendered breathable again.

It is obvious that instead of the liquid receptacle 35 36 37 dry filters can be used if necessary or desirable, and that the principle set forth allows of the use of any kind and number of purifying layers, wet or dry.

In the apparatus shown in Figs. 18 to 26 a number of dry filters and liquid receptacles are also provided for purifying the air, cartridges being used for the dry filters, stopping devices for the liquid, air spaces to facilitate breathing and an arrangement for the preliminary cleansing of the air. The following must be added, however.

Known means are used in this apparatus to facilitate breathing, *viz*: the cleansing of the smoke-filled air by filtration and passage through liquid, the rendering breathable of exhaled air, the supply of oxygen from a reservoir of compressed oxygen, the suction of fresh air from the open atmosphere by means of a suitably long tube. These arrangements are, however, according to my invention, so combined that if necessary one or the other can be disconnected and that in every case the most efficient co-operation of the various parts can be ensured and finally that in no case the failure of one of the arrangements will result in danger to the user of the apparatus.

Fig. 26 is a diagram illustrating the invention. It is assumed that smoky air enters the apparatus at 61 and passes into the mouth tube at 62. From 61 the smoky air first passes through a preliminary filter 63, then successively through dry filters 64 and 65, then through a liquid receptacle 66 to a breathing bag 67, then to a filter 68 and another liquid receptacle 69 and at 62 to the breathing tube. During this passage the air is cleansed in the known manner so it is unnecessary to describe the arrangement of the various filters and liquids, The exhaled air returning to 62 is then as indicated by line 70 conducted into the breathing bag 67 where it is mixed with the smoke impregnated air preliminarily cleaned, and passes with the latter through the carbonate of lime filter 68 and the liquid receptacle 69, so that the carbon dioxide becomes combined and the temperature lowered. At 62 the exhaled air rendered breathable again in this manner is again inhaled together with the completely cleansed air from the smoke charged place.

The oxygen after suitable reduction of pressure is taken from a vessel 71 containing compressed oxygen, conducted into an expansion vessel 72 and then mixed with the smoke charged cleansed air and the exhaled air inside the filter 68 whereupon it is passed to 62 through the receptacle 69.

The fresh air sucked in from outside by means of a suitably long tube, if used at all, introduced into the filter 64 where it follows for the rest the passage of the smoke impregnated air.

In the second form the breathing bag 67 is dispensed with because, as indicated by line 73 the exhaled air is directly returned to 61 that is to say, is forced out at the inlet of the smoke impregnated air but at the succeeding exhaling period is inhaled again together with the said smoke impregnated air (so that it becomes mixed with the latter, and describes the same path). In this case the exhaled air passes through the lime filter and is rendered breathable by the combining of the carbon dioxide; this has the further advantage that the exhaled air is more efficiently cooled on the long course than when passing only through 67 68 and 69.

The different receptacles are so grouped that a compact and yet an easily accessible apparatus is obtained which can be easily fastened to the back of the person entering the place filled with smoke. The joints and connections are formed in such a manner that the removal or insertion of one or the other part for permitting the breathing can be effected in the shortest possible time and especially the regulation of the oxygen supply according to requirement can be effected in an easy manner during the use of the apparatus.

In the first device (Fig. 18) the oxygen receptacle 71 is arranged in the centre, the filters 64 65 and the liquid receptacle 66 being on one side and the breathing bag 67, the lime filter 68 and liquid receptacle 69 on the other. The expansion vessel 72 is formed as a base and acts as a support for the oxygen jar 71 and has an upwardly projecting flange 74, in which said jar is placed. The preliminary filter 63 is also arranged in the centre of the apparatus, in front of the oxygen jar 71.

The smoky air entering at 61 passes through the preliminary filter 63 and conduit 75 to the filter 64. From here through conduit 76 to the filter 65 then through conduit 77 to the liquid receptacle 66 through conduit 78 to a rubber breathing bag 67 arranged inside a closed cylinder, through conduit 79 to the lime filter 68 then through conduit 80 to the liquid receptacle 69 and finally after passing the inhaling valves 81 to the mouth tube 62.

The exhaled air returning through the mouth tube 62 during the exhaling period is conducted through conduit 82 and the opening exhaling valves 83 (the inhaling valves 81 closing simultaneously, to the breathing bag 67 and then conducted back in a breathable condition to 62 by means of the conduits 79 and 80 through the lime filter 68 and liquid vessel 69.

The oxygen bottle 71 is, as clearly shown, in Figs. 18, 19, 20, provided with the necessary valve stopper, in order to regulate the pressure to the desired extent, two manometers being provided to indicate the pressure in the jar and behind the valve. The oxygen jar is placed in the flange 74 of the expansion vessel 72 as above mentioned without any other fastening (see Figs. 19 and 22). The connection of the valve stopper with the tube 84 is then established by means of the nut 85. When the pressure has been reduced to a certain extent by means of the valve, about one third of an atmosphere indicated pressure, the cock 86 is opened. The oxygen then passes first through the large tube 87 and the conduit 88 into the expansion vessel 72. From here a tube 89 passes forwards to the right hand side of the person using the apparatus and leads to the lime filter 68. In this tube 89 a cock 90 is inserted, which is situated at the side of the person, using the apparatus, so that it can be easily reached by the hand. From the filter 68 the oxygen passes through conduit 88 to the receptacle 69 and then finally to the mouth piece 62.

The fresh air enters immediately behind the preliminary filter when a tube of suitable length has been screwed on at 91 and then takes the same course, as the smoke impregnated air.

The usual method of using the apparatus is as follows: Union 91 is closed by means of a cap, and therefore no hose leading in the open air for the introduction of fresh air is used. The three operations then taking place, are the cleansing of smoky air, rendering breathable exhaled air and the supply of oxygen. In this manner the most economical use of the artificially introduced oxygen is arrived at, which is of great importance, because from experience the oxygen from the jar, is very rapidly used and it is impossible to carry large jars or a greater number thereof on account of their weight. A further point of consideration is that the same quantity of oxygen is not always needed according to the kind of smoky air met with, the person inhaling will notice from the greater or less difficulty he experiences in breathing whether more or less oxygen is required. If therefore by means of the reducing valves a certain pressure is produced in the first instance, the person can during the use of the apparatus regulate the supply of oxygen by manipulating the cock 90, so that the process of breathing is uniform and the oxygen is used in the most economical manner as required. If during use the oxygen jar should become exhausted which can very easily occur the cock 90 is closed. The air cleansed of smoke together with the exhaled air, again rendered breathable, will always be sufficient to prevent the person from being suffocated, although living in the smoky atmosphere will of course be more difficult. If no easily accessible shutting off arrangement corresponding to the cock 90 were provided, the useless supply spaces formed by the oxygen jar, the expansion vessel and the connections between them would interfere with the process of breathing.

It may happen no oxygen is in the jar before the apparatus is taken into use, in which case the nut 85 is loosened, and the bottle with its stopper is removed, whereupon the cock 86 is closed. The person must then enter the smoky atmosphere without a supply of artificial oxygen, which is possible for a certain time. The advantage is then obtained that the weight of the oxygen jar and stopper has not to be carried. The closed cock 86 prevents entrance of smoky air through the oxygen conduit.

In cases where the use of a hose leading into the open air becomes necessary, it can be connected at 91. The danger of using hoses of this kind lies in the fact that they are liable to become entangled or engage obstructions, thus preventing the entrance of fresh air. If this should occur when using the apparatus, the person is in no danger, as the smoke charged air entering at 91 is first cleansed and the exhaled air again rendered breathable. By opening the cock 86, oxygen can be mixed with the air; should difficulty be experienced in breathing if the supply of fresh air should be interrupted. If the hose becomes detached so that smoky air enters the union 91, this smoky air together with that entering at 61 will be cleansed and can therefore also be inhaled. Should the hose therefore form an obstacle to advance it can be purposely cut or detached.

Experience has shown that the user is likely to open the pressure reducing valve in the stopper of the oxygen jar too much, which is liable to occur during excitement. It is therefore useful to limit the stroke of the reducing valve to a fixed maximum by the use of a stop or the like, or to use a reducing valve which does not allow the pressure to exceed a certain fixed limit which may be ascertained by practice. For the reasons already given the waste of oxygen must be avoided as much as possible.

The action and manipulation of the apparatus shown in Figs. 24 and 25 is exactly the same. This apparatus is distinguished externally from the other, that the breathing bag 67 is dispensed with and that the exhaled air is brought directly to 61 through conduit 92. The attachment of the apparatus is effected by loops 93 93 through which straps are passed.

Fig. 27 shows on a reduced scale a plan view of the apparatus substantially corresponding to Fig. 18. The difference is as follows: It has been found that on completely closing the cock 90, the pressure of oxygen behind it is soon increased in such a manner, that the reducing valve blows off, whereby a great loss of oxygen takes place. To prevent this, the reducing valve not arranged on the oxygen jar, but removed to the part where in Fig. 18 the cock 90 is situated, that is to say, to the side of the person using the apparatus This reducing valve is marked 94 in Fig. 27. The conduit from the oxygen jar is then not first passed through the expansion vessel 72 but immediately to the part of the reducing valve 94 and close to the latter, and towards the oxygen jar a regulating and closing valve 95 is placed. The conduit 96 then leads only from the valve 94 to the expansion vessel 72. Assuming that the reducing valve, as previously mentioned is set for a fixed maximum pressure, the person using the apparatus can obtain the measured off fixed pressure in conduit 96 by opening this reducing valve. If the person desires to regulate the supply it is effected by manipulating the easily accessible regulating valve 95. However, if the supply of oxygen is to be completely cut off, the valve is closed and in this case a blowing off of the oxygen cannot take place, as is the case with cock 90 in Fig. 18. The conduit between the oxygen jar and the valves 94 and 95 has of course, to be sufficiently strong to stand the full pressure existing therein.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is:

1. A device for shutting off the cleansing and cooling liquid of breathing apparatus during movement of the latter, consisting of a tube having a chamber or double bottom, with one or more lateral apertures for passage of air, substantially as described and shown in Figs. 4 and 5.

2. A device for shutting off the cleansing and cooling liquid of breathing apparatus during movement of the latter, consisting of a small tube having a chamber or double bottom, the annular slot or space of which is partly closed by a perforated wall substantially as shown and described in Fig. 5.

3. A breathing apparatus with dry filters and liquid receptacles in which, inside the liquid receptacles narrow apertures for the passage of air are provided extending in or approximately parallel to the direction of movement of the cleansing liquid, the latter flowing past said apertures during movement of the apparatus, substantially as described and shown in Fig. 2, 12, 15, 16, 21, and 23.

4. A cylinder or cartridge closed on all sides and provided at top and bottom with sieve like plates, enclosing the filtering mass and means for fastening said cylinder or cartridge in breathing apparatus substantially as described and shown in Fig. 6.

5. A cylinder or cartridge closed on all sides containing filtering mass and provided with a screw thread for screwing it to the female threaded parts of the breathing apparatus substantially as described and shown in Fig. 6.

6. A breathing apparatus having several dry filters consisting of screw-threaded cylinders or cartridges containing filtering mass, substantially as described and shown in Figs. 1, 2, 12, 15, 17, 21 and 23.

7. A breathing apparatus with an arrangement for the preliminary cleansing

of the air, consisting of a renewable cotton wool filter situated directly behind the smoke or injurious gas inlet, substantially as described and shown in Figs. 1, 7, 8, 9, 10, 11, 12, 13, 17, 19, 20, 24 25).

8. A breathing apparatus having several dry filters above and below which large air spaces are provided substantially as described and shown in Figs. 1, 2, 12, 15, 17, 21, 23.

9. A breathing apparatus with four dry filters having large air spaces, between which a liquid receptacle is situated, so that the air, after passing through a device for preliminary cleaning, flows in two pairs of dry filters and then through the liquid receptacle to the breathing tube, substantially as described and shown in Figs. 11, 12 and 13.

10. A breathing apparatus, in which the external air passes through several wet or dry filters provided with large air spaces and then through other filters, some of which contain charges adapted to combine with carbon di-oxide, while the exhaled air to be rendered again breathable is sucked back through the carbon di-oxide binding filter, substantially as described and shown in Figs. 14, 15. 16 and 17.

11. A breathing apparatus as in Claim 10, in which the receptacles for receiving the filters and liquids are grouped in such a manner, that three of each are placed to the right and left respectively, while a breathing bag is arranged in the centre in which an additional dry filter can be provided substantially as described and shown in Fig. 14, 15, 16 and 17.

12. A breathing apparatus in which the injurious gases are removed, the exhaled air rendered breathable and artificial oxygen introduced, means being provided by which the supply of oxygen can be cut off or regulated as required, substantially as described and shown in Figs. 18 to 26.

13. A device for permitting breathing in spaces filled with injurious gases as in Claim 12 in which the oxygen conduit is brought close to the hand of the user and provided at this point with a regulating and shutting off device, substantially as described and shown in Figs. 18 to 27.

14. A device for permitting breathing in spaces filled with injurious gases as in Claim 12, in which a connecting piece for a hose leading into the open is so arranged that the fresh air describes the same course as the injurious gases, substantially as described and shown in Fig. 18 to 27.

15. An apparatus for permitting breathing in spaces filled with injurious gases as in Claim 12 in which the exhaled air is brought directly back to the inlet of the injurious gases, so that it is exhausted into the atmosphere but immediately drawn in again with said gases, substantially as described and shown in Figs. 24, 25.

16. In a breathing apparatus supplied with oxygen and adapted to be strapped to the back of the person, the provision of a tube, reaching to the side of such person and provided at this point with a regulating and shutting off device, substantially as described and illustrated.

17. In a breathing apparatus supplied with oxygen and adapted to be strapped to the back of a person, the arrangement that the reducing valve of the oxygen jar is separate from the latter and removed to the side of the person carrying the apparatus, and connected with said oxygen jar by a conduit of suitable strength, a reducing valve set to a fixed maximum pressure being adapted to be placed in close proximity to a shut off and regulating valve, substantially as described and shown in Fig. 27.

Dated this 13th day of February 1903.

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18 Buckingham Street, Strand, W.C.

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Fig.1

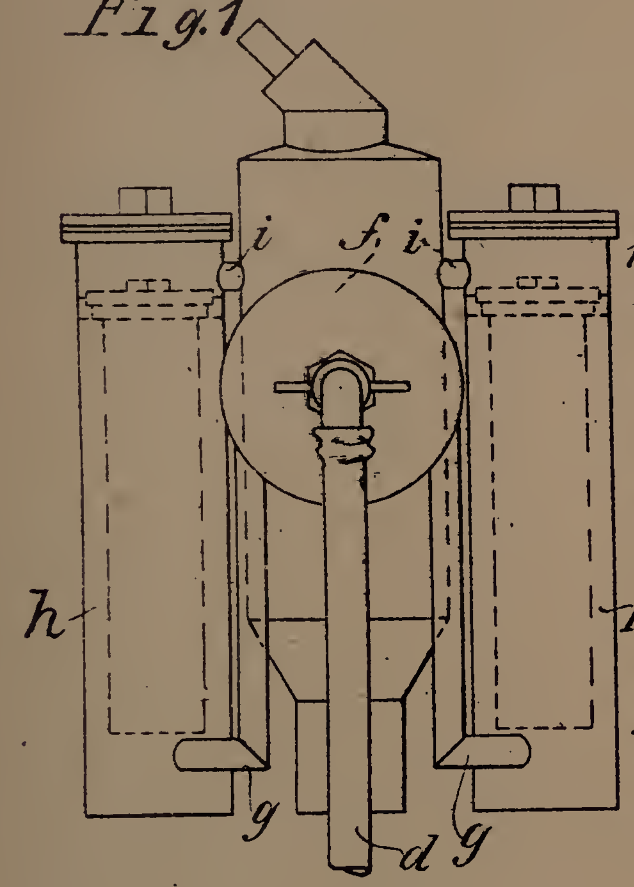

Fig.2

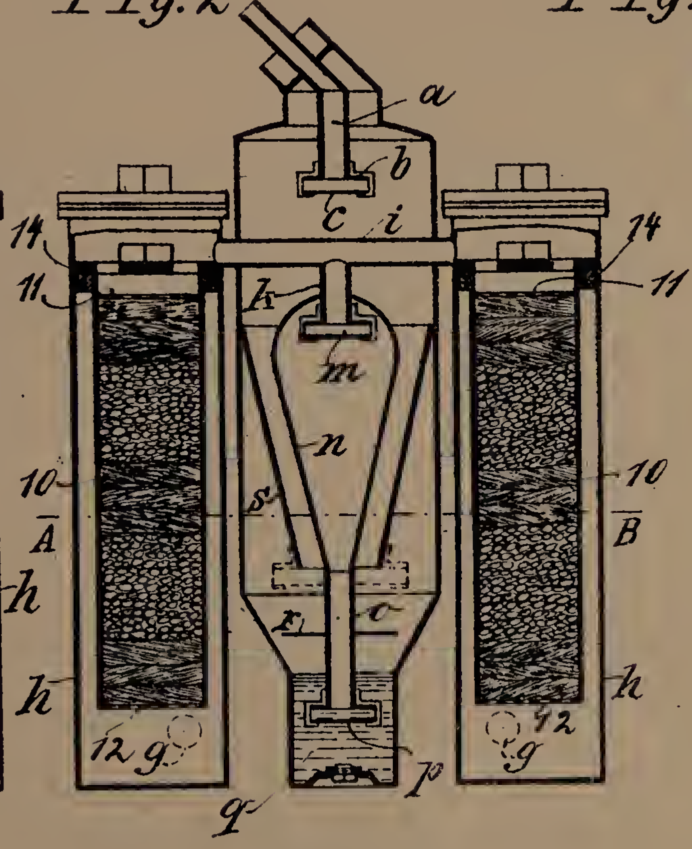

Fig.6

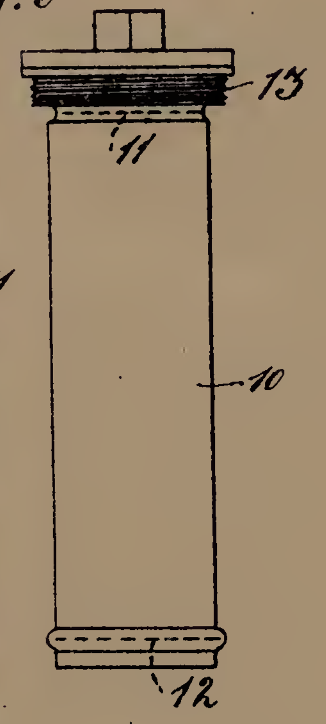

Fig.7

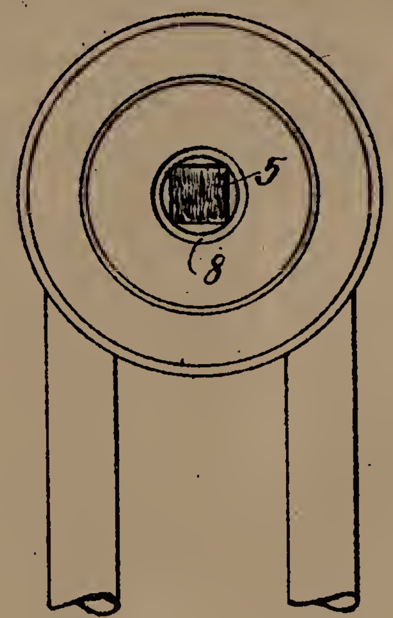

Fig.8

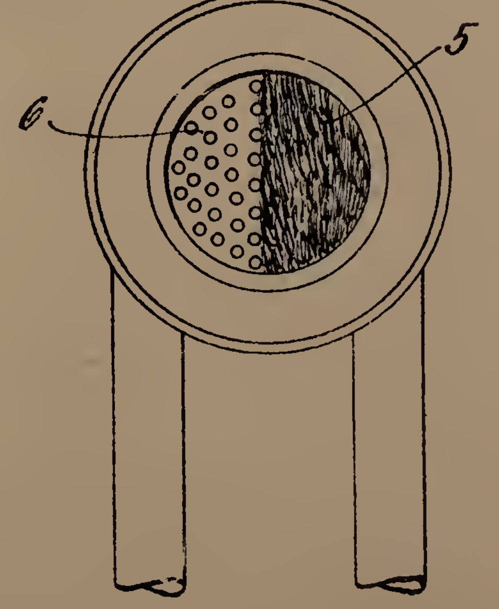

Fig.5

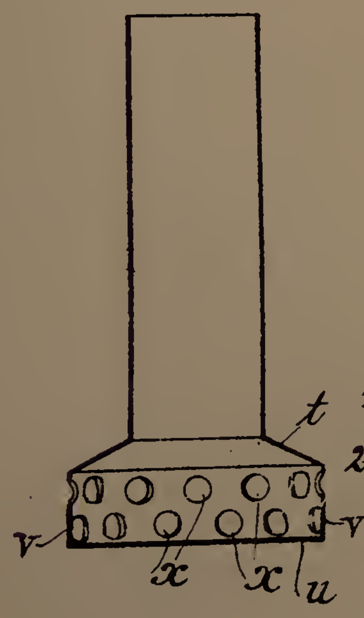

Fig.4

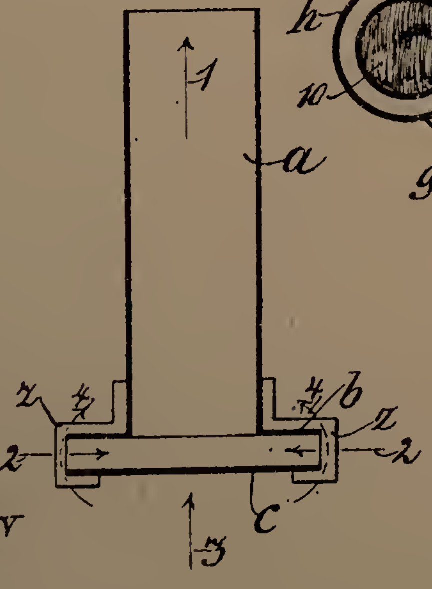

Fig.3

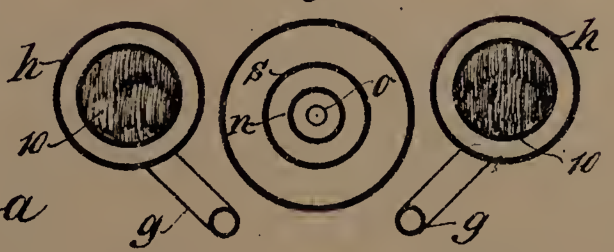

Fig.9

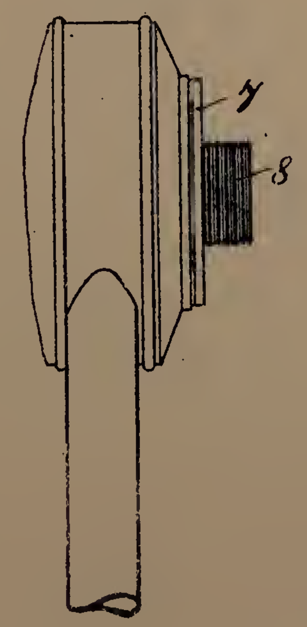

Fig.10

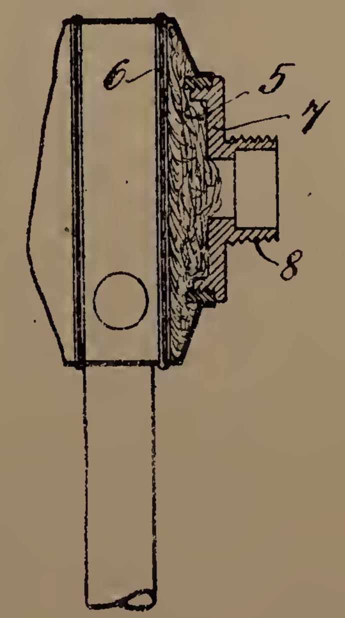

Fig.11

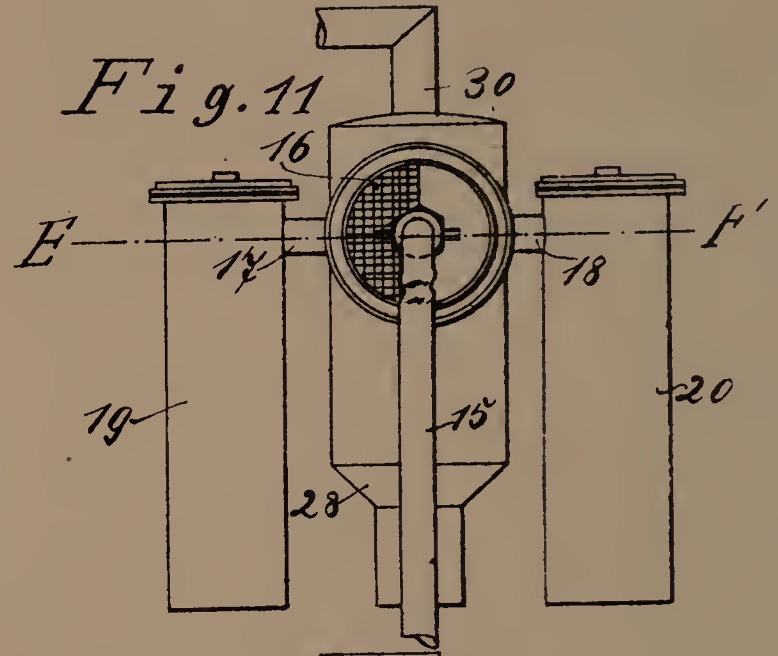

Fig.12

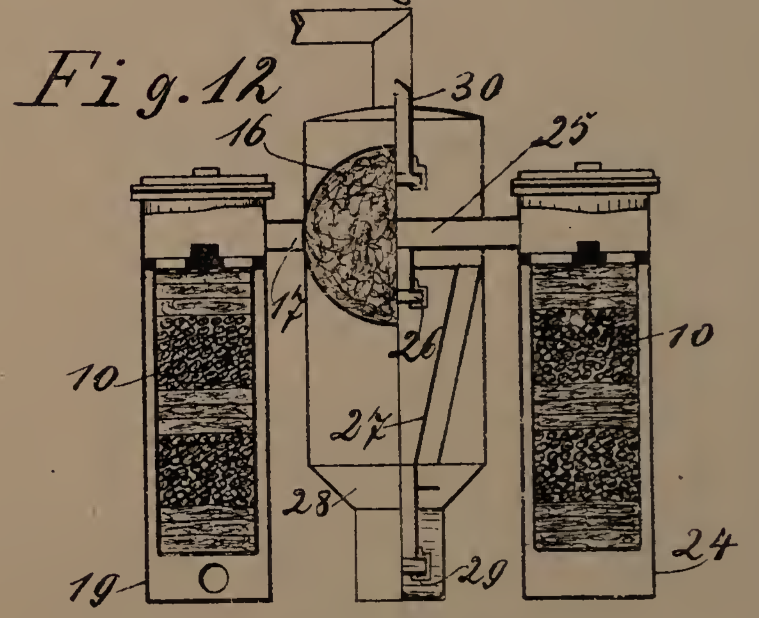

Fig.13

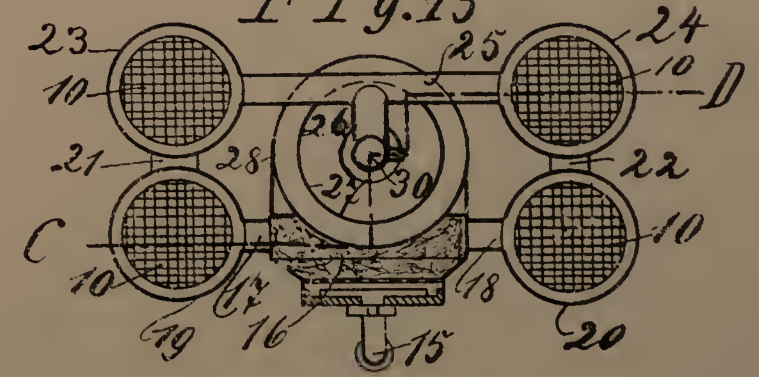

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Fig. 14

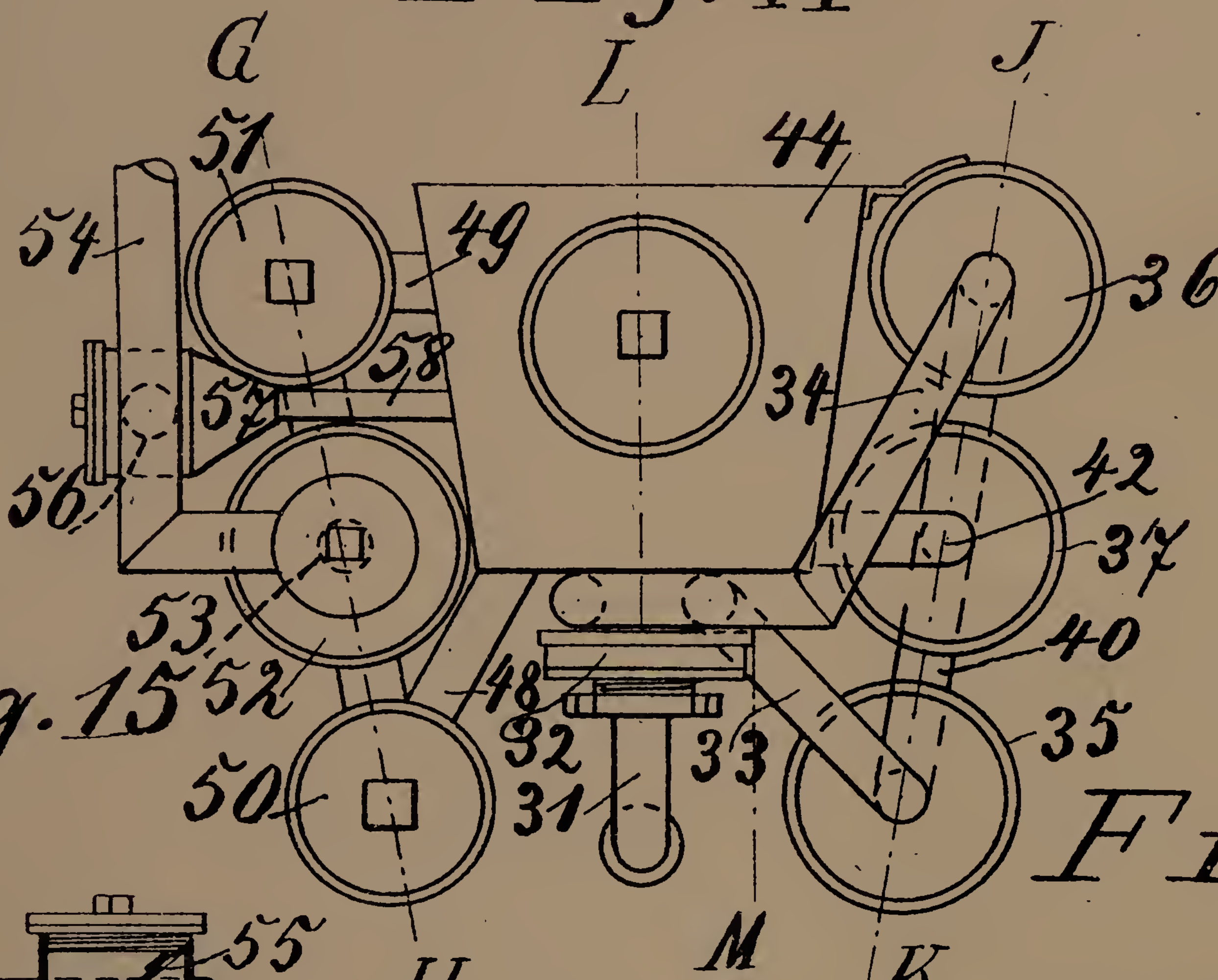

Fig. 15

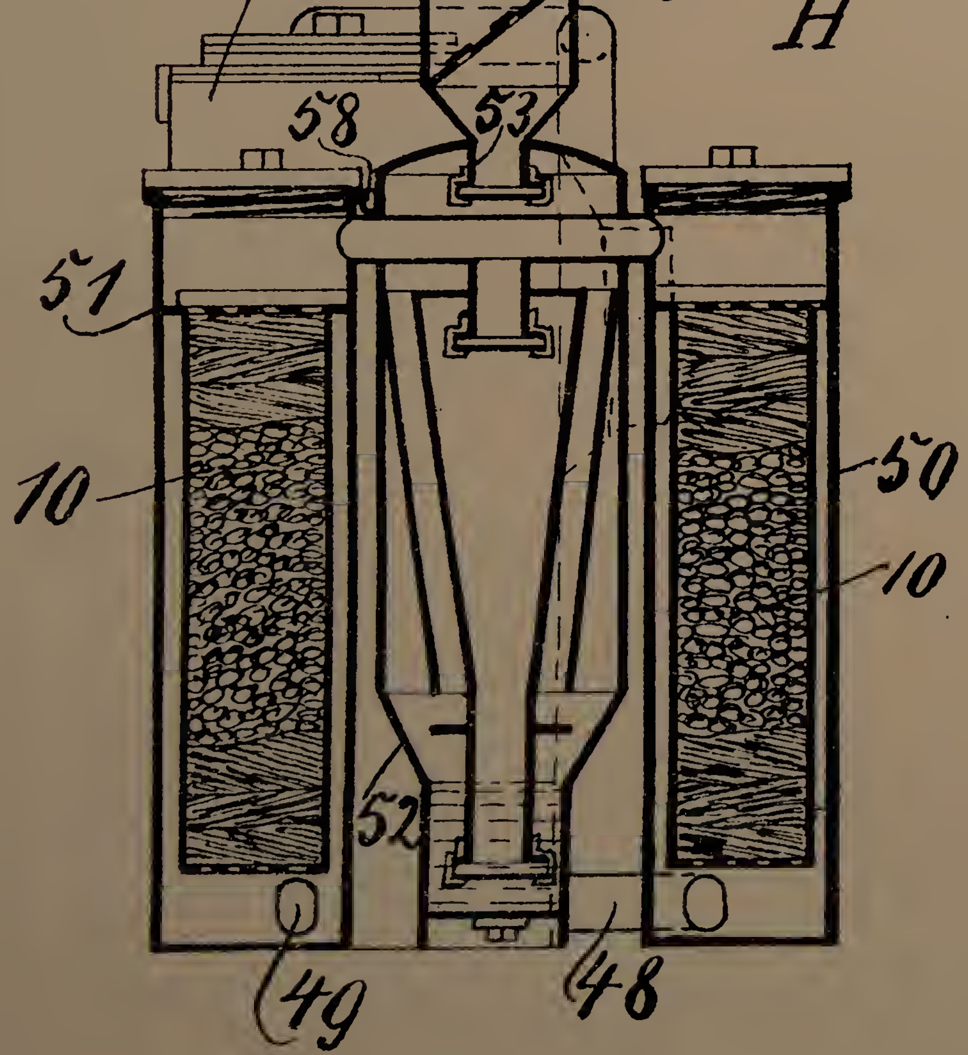

Fig. 16

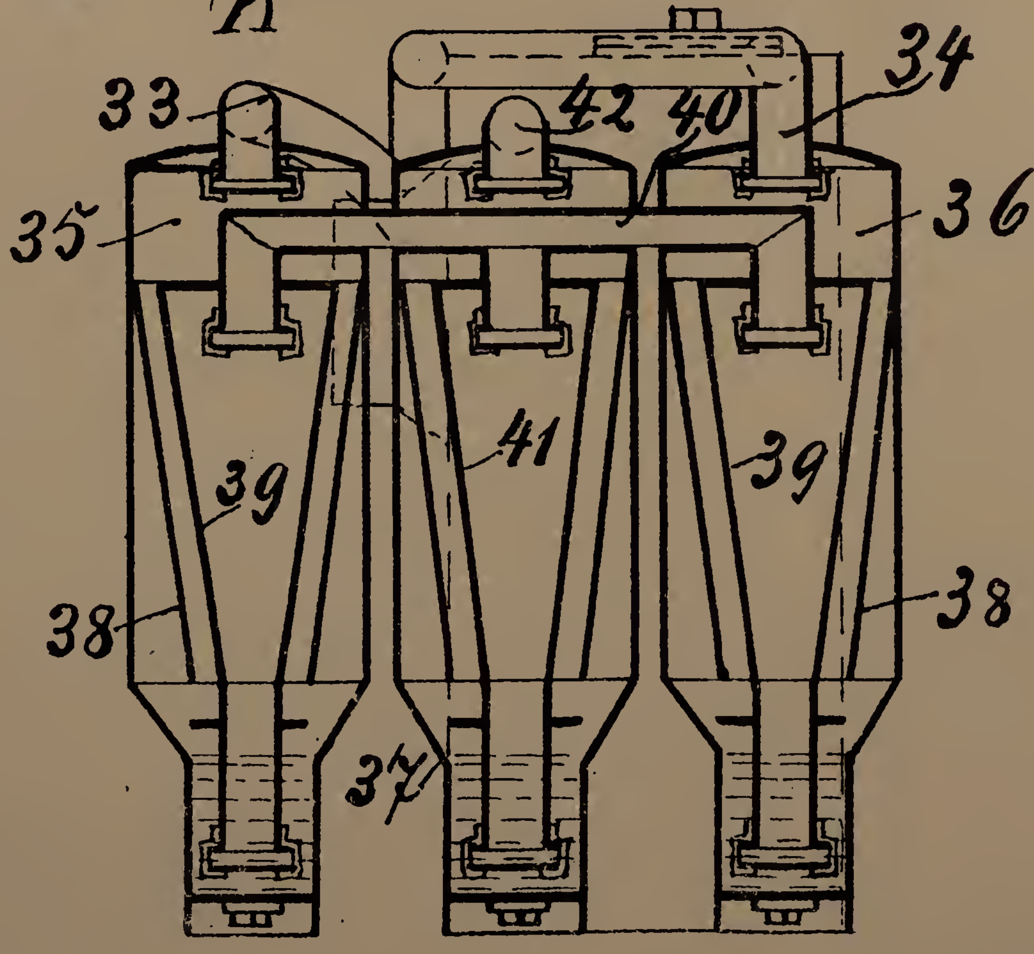

Fig. 17

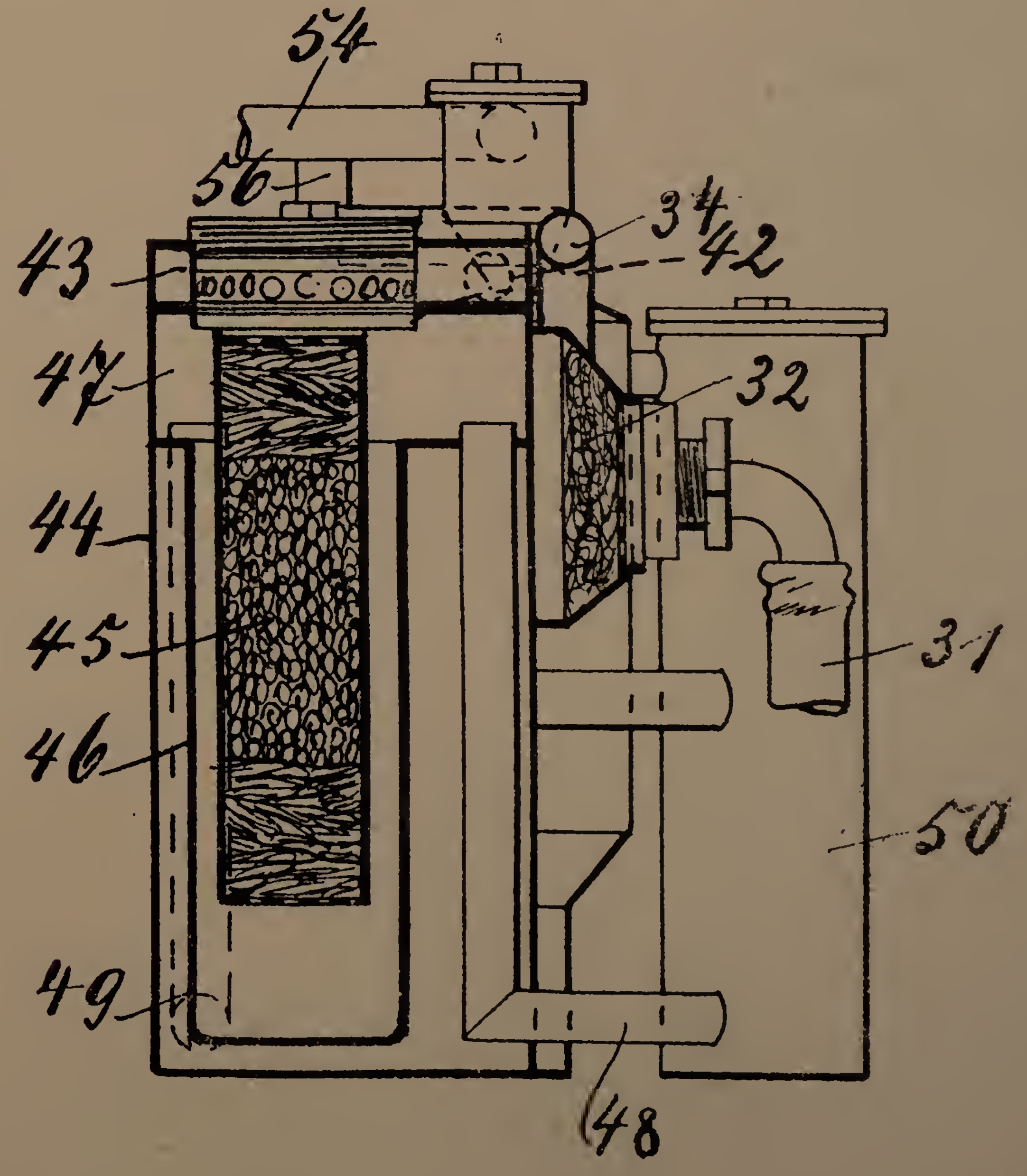

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Fig. 18

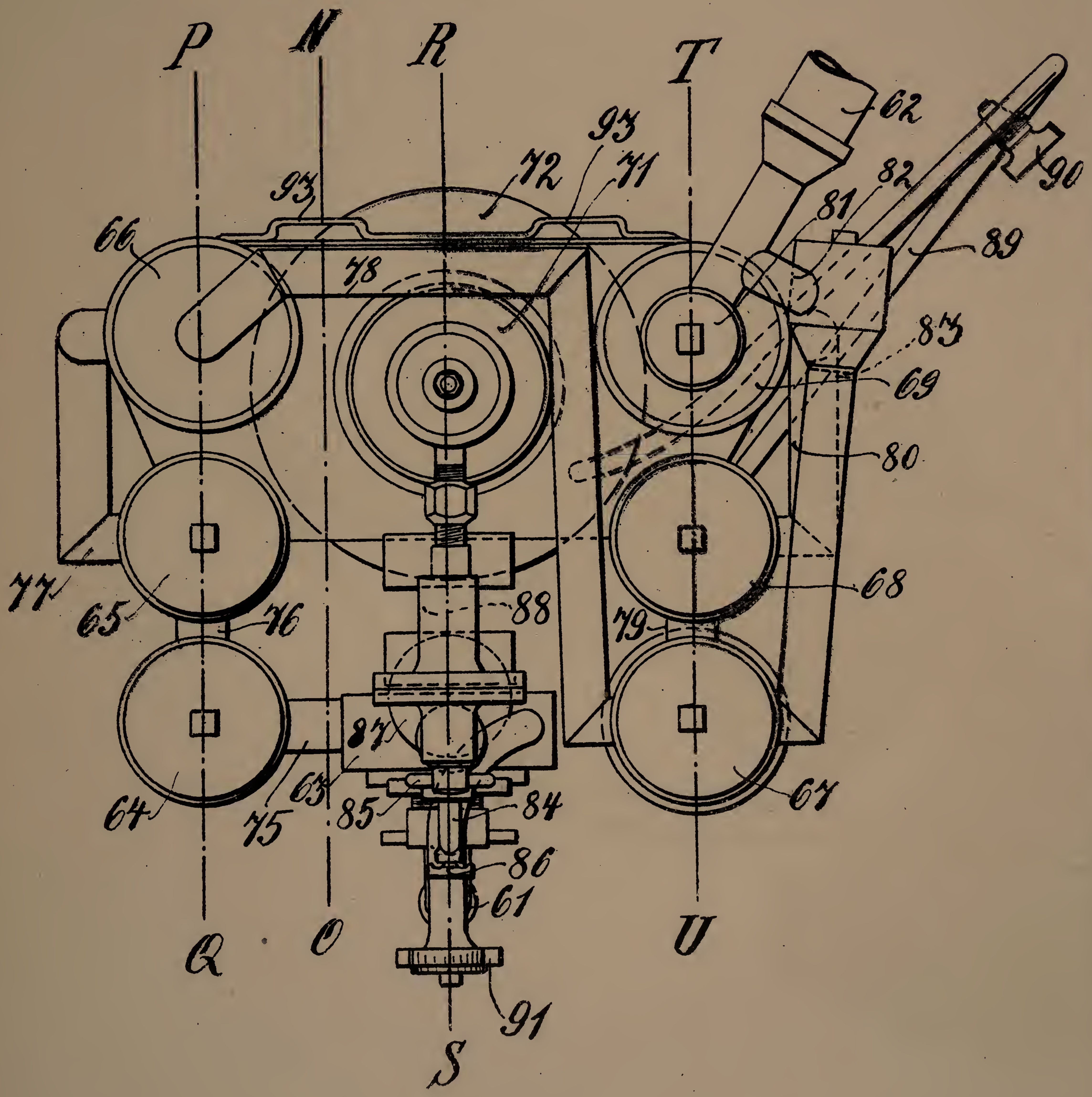

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Fig. 20

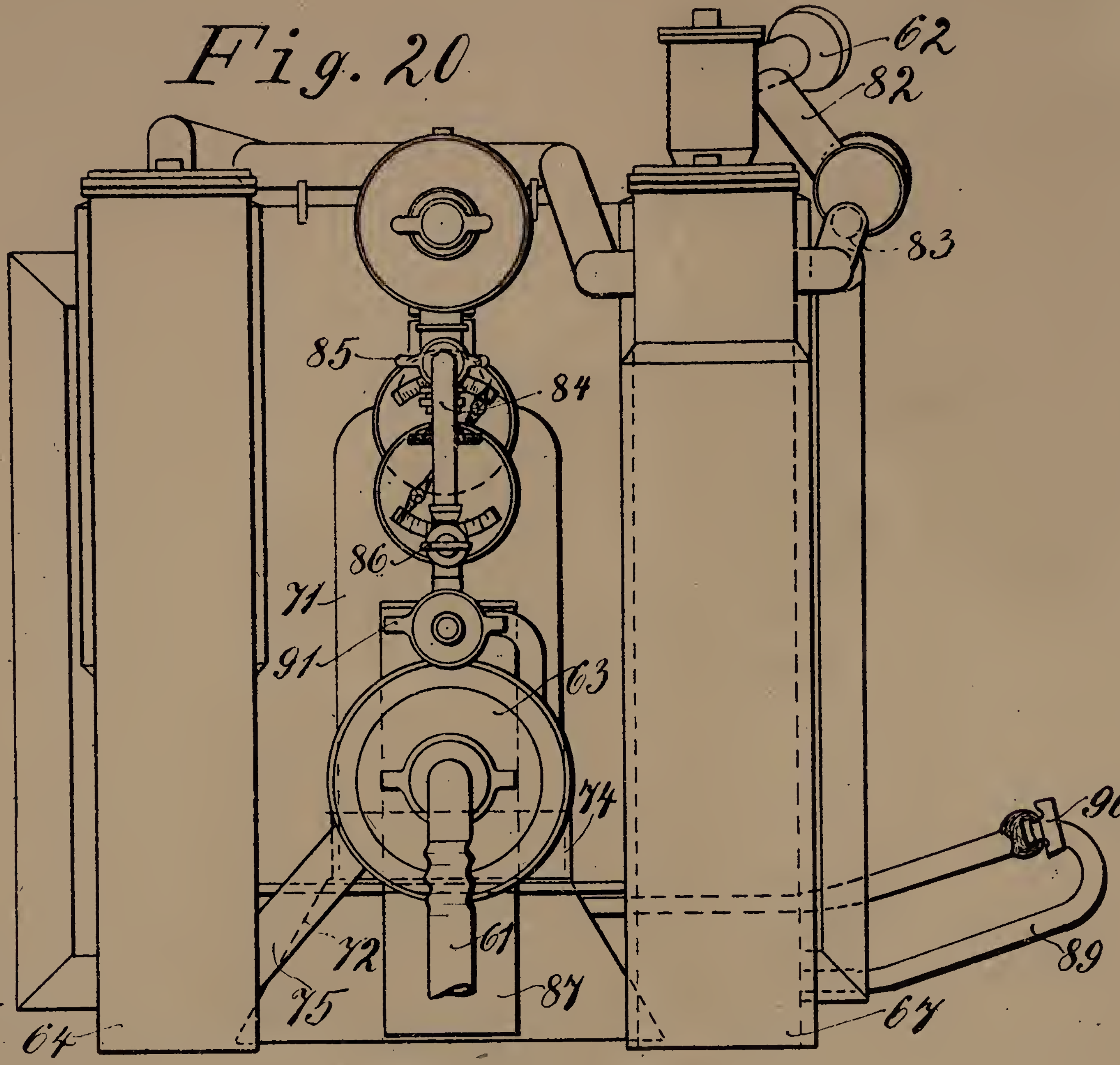

Fig. 19

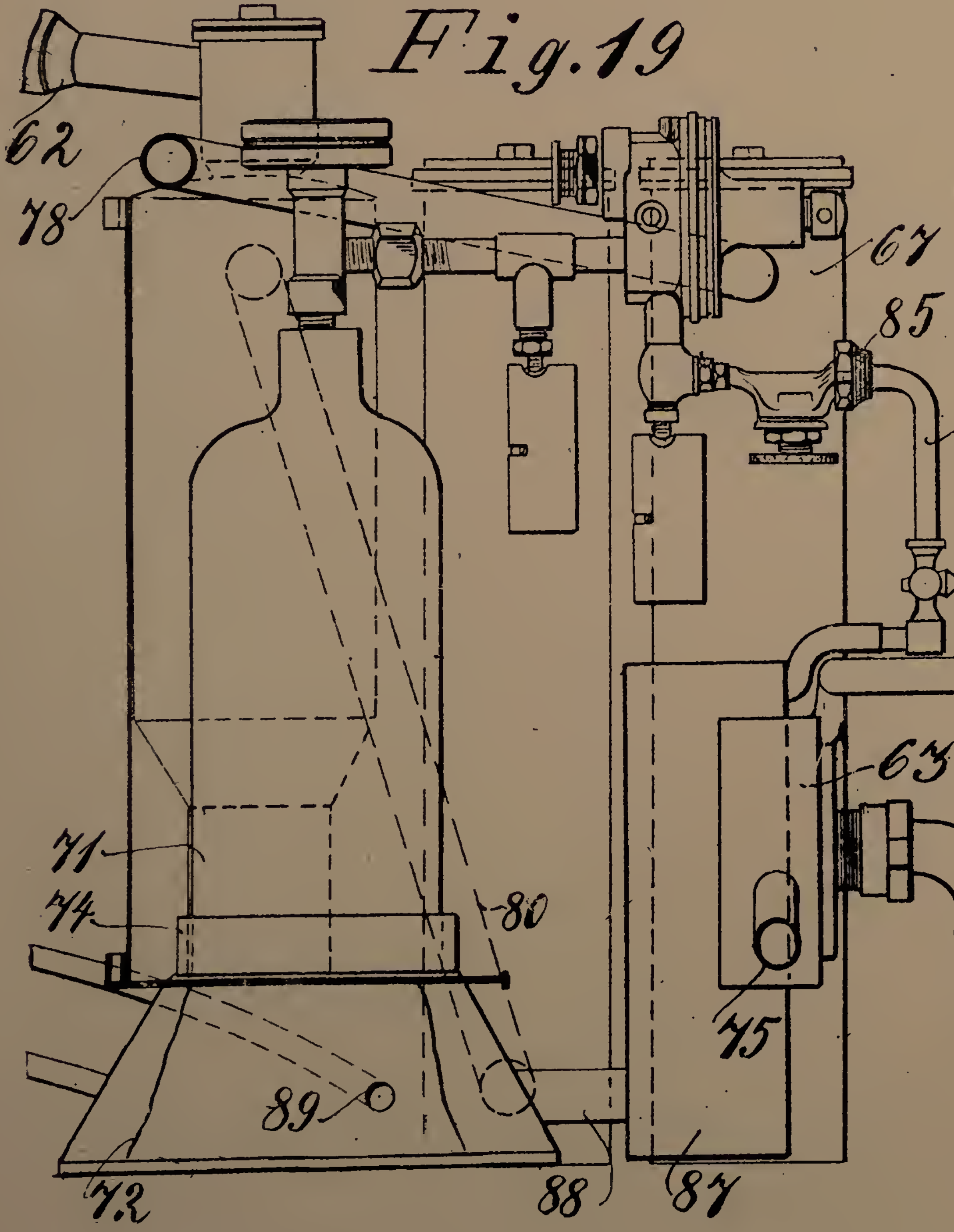

Fig. 27

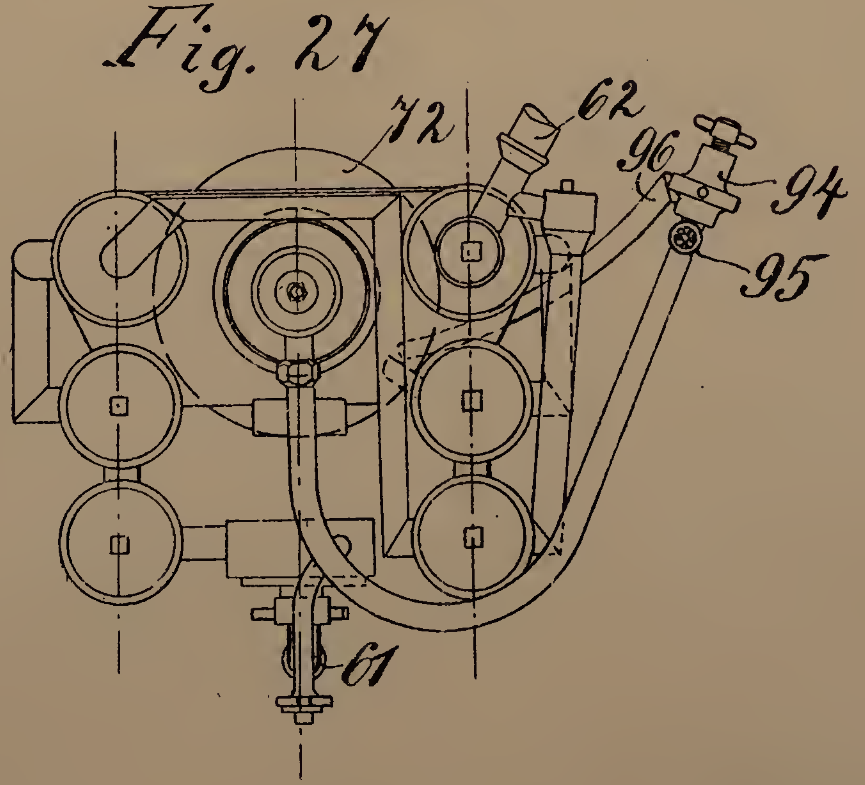

Fig. 21

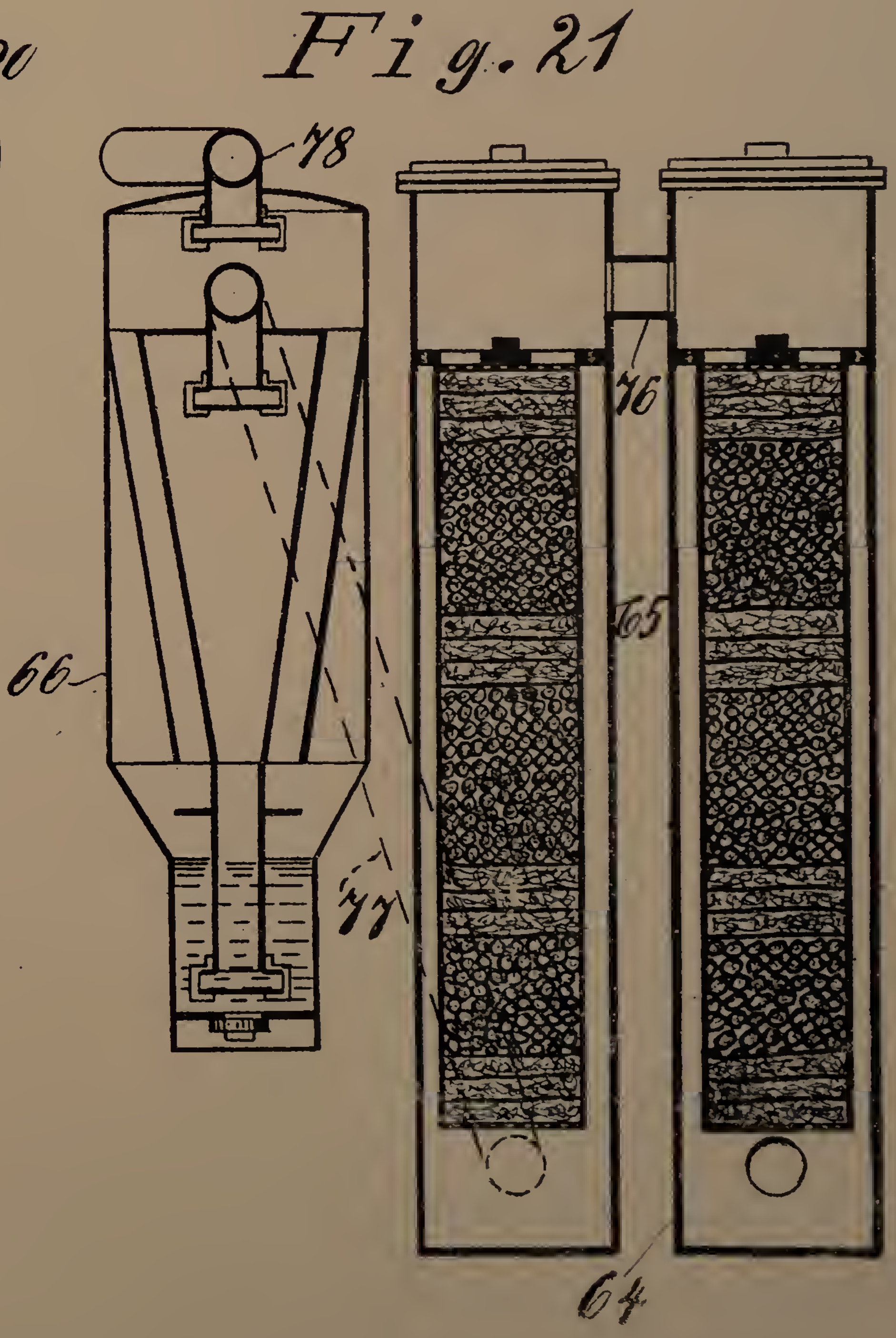

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Fig. 25.

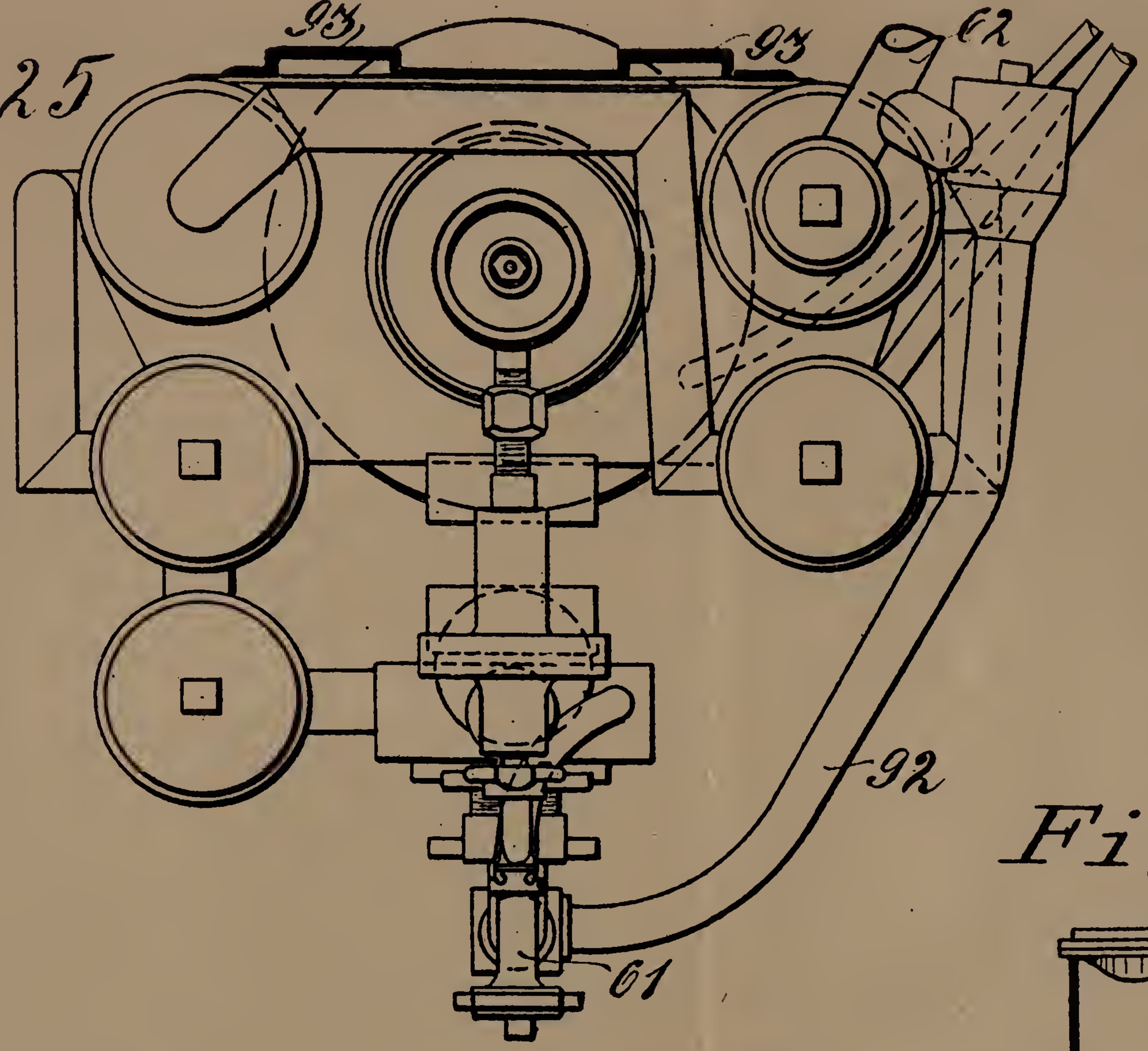
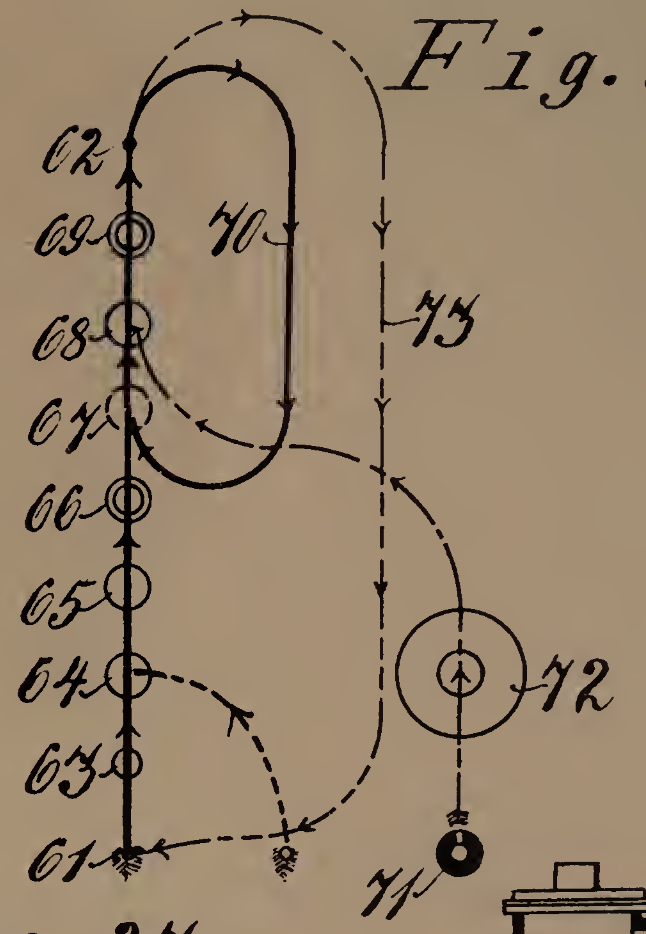


Fig. 26.



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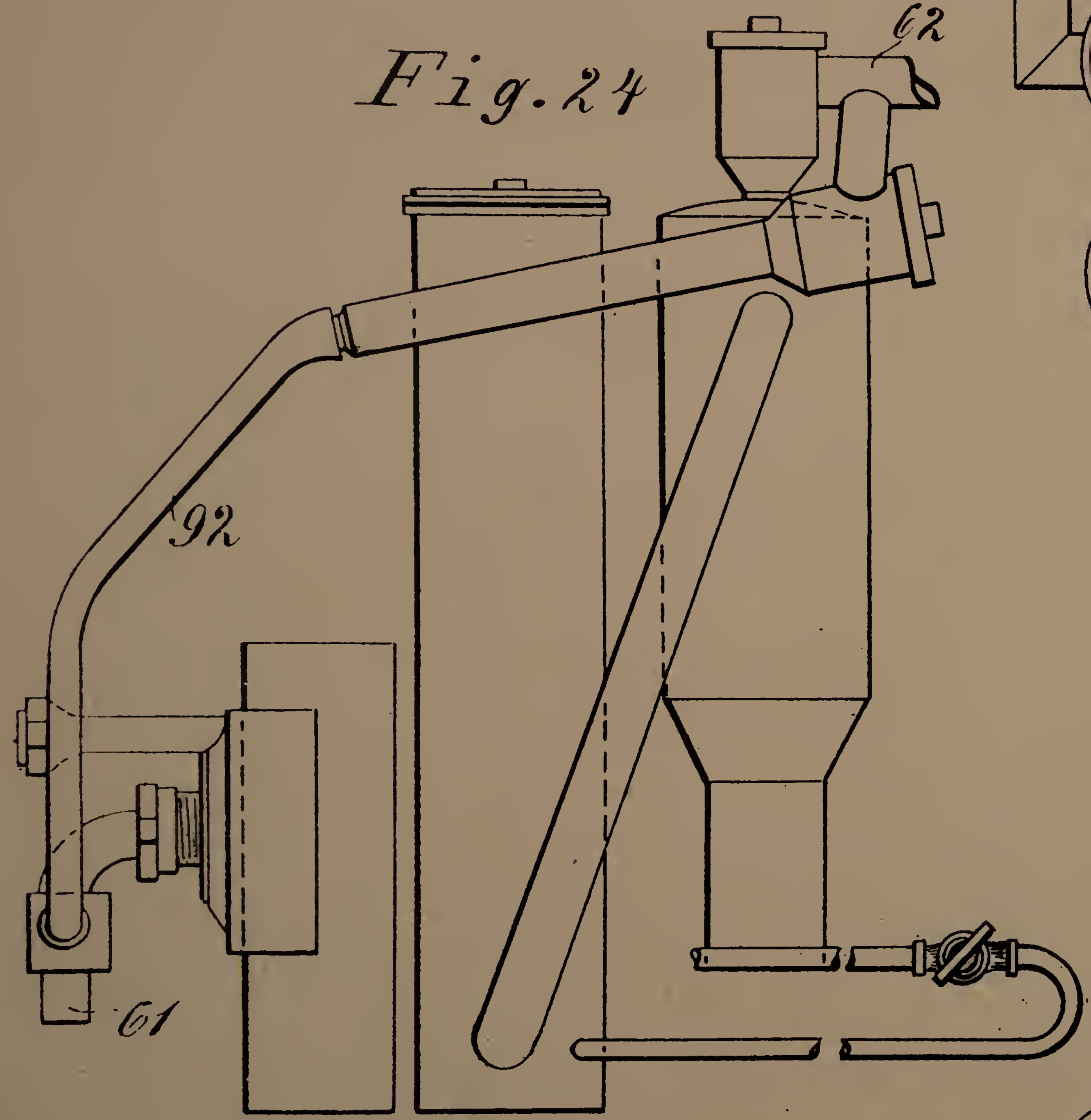


Fig. 22.

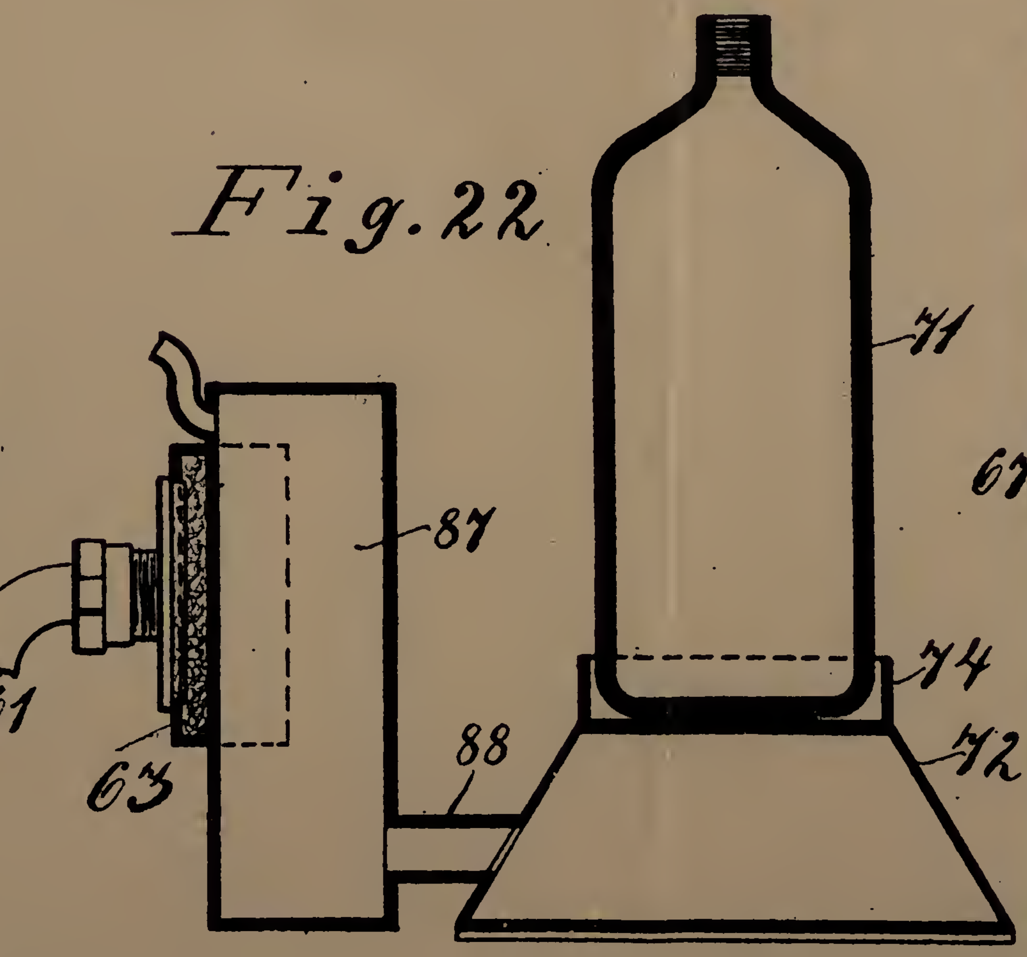
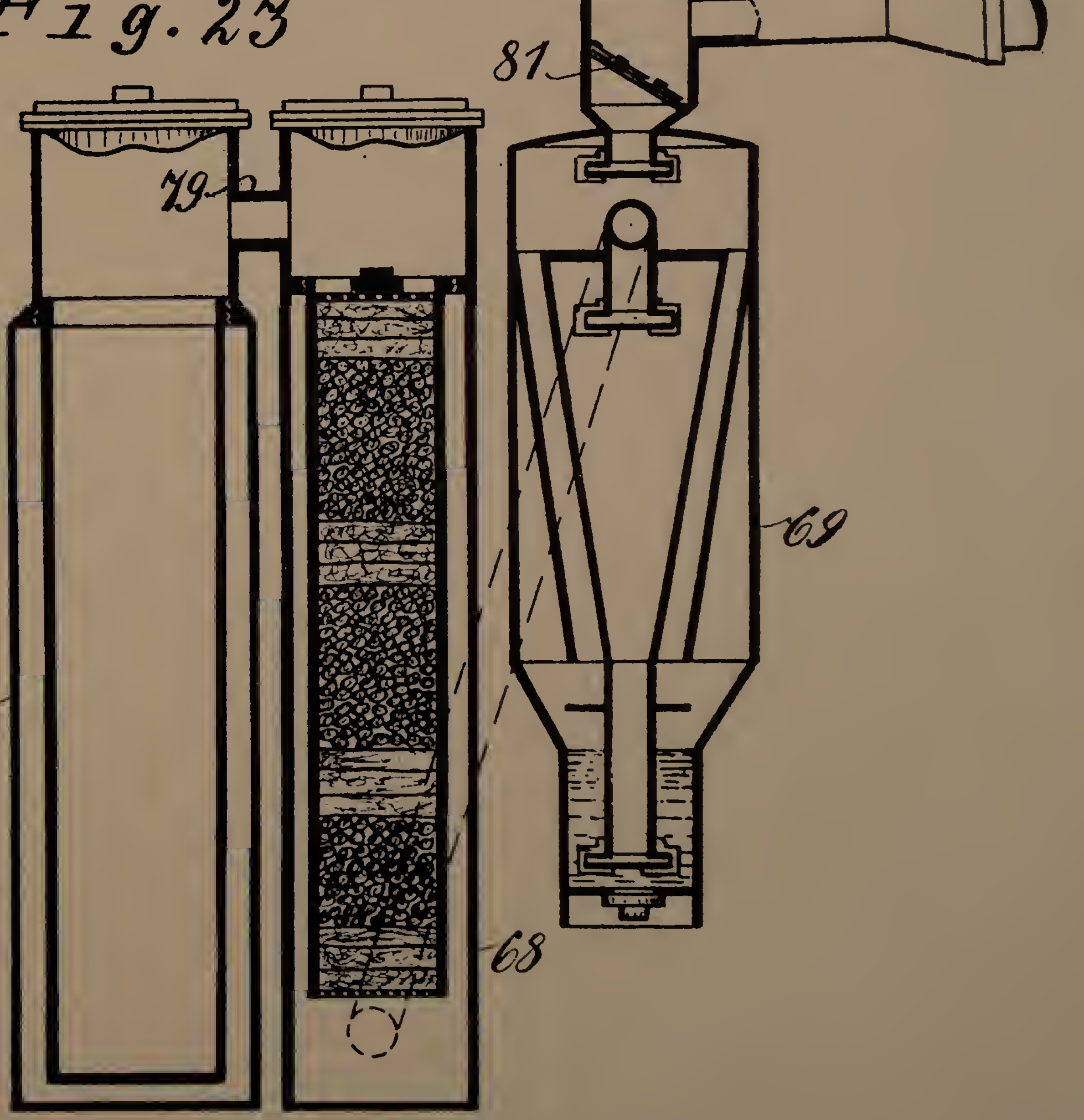


Fig. 23.



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